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IMPROVING THE QUALITY OF SECONDARY FIBER RAW MATERIALS STUDYING A PROCESS.

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ABSTRACT

The article presents the results of improving the quality of waste paper by converting the printing ink in the MS-3 waste paper mass into a soluble state. The necessary conditions for the solubility of printing ink in the waste paper mass have been recommended.

KEYWORDS: *Waste Paper, Paper, Alkali, Degree Of Polymerization.*

INTRODUCTION

According to the report "Pulp and Paper Market Size, Share & COVID-19 Impact Analysis… and Regional Forecast, 2020-2027" provided by Fortune Business Insights, the pulp and paper market will grow by an average of 0.8% per year by 2027 reaching a volume of 368,1 billion USD. The authors of the report divide the market into three sectors, namely newsprint, printing and packaging paper, among which packaging paper has the largest share (52.9%) [1].

To produce one ton of paper, 24 trees need to be cut down. During the year, one tree produces enough oxygen for 4 people [2]. In this regard, annual plants, non-wood perennials, the rational use of fibrous waste from the main production is of particular importance.

Secondary resources in our republic - from annual plants such as cotton wool [3], cotton stalks [4], straw [5]; non-woody plants, including tapinambur [6], amaranda remnants [7], and licorice root waste [8] have the potential to be used in the paper industry to obtain a fibrous semi-finished product.

The pulp and paper industry is the sixth largest industry in terms of water consumption, consuming 163 m3 of water per 1 ton of product, the bulk of which falls on the production of fibrous semi-finished products.

One of the main directions of reducing water consumption is the efficient use of waste paper (waste paper, recycled paper, secondary raw materials).

In the paper industry, recycling of waste paper can reduce water consumption by 40%, solid waste by 39% and air pollution by 73% [2].

Worldwide, newsprint is made from 68% of secondary raw materials. At the same time, 68% of all paper produced worldwide is a packaging paper, and its composition consists of 50% recycled paper, i.e. waste paper. However, waste paper is almost never used in the production of printing and writing paper. Even in the US, only 6% of waste paper is used for this purpose. This means that almost 90% of the primary fiber in the production of printing and writing paper, i.e. cellulose from wood, is used. And that in turn signifies that the forest will be cut down again. MS-1, MS-2 or MS-3 sort waste paper can be used in the production of printed paper. Although there is no problem in using MS-1 and MS-2 waste paper, the presence of printing ink in MS-3 waste paper limits its use for the above purposes. In particular, the problem of maximum separation of dye on the fiber surface during the processing of waste paper, its removal from the cellulose suspension, decolorization of dyed fiber and raising the whiteness of secondary fiber is currently being studied in all developed countries [10].

LITERATURE REVIEW

When the composition of paper waste generated in different enterprises was studied by NMR analysis, a researcher, it was found that a certain amount of polycyclic aromatic compounds, heavy metal, dioxin and furan compounds were present [11]. An analysis of the literature revealed that it was a multi-component system used in the preparation of typographic ink. Printing ink is supposed not to penetrate deep into the paper and to dry quickly. For this purpose, typographic inks are prepared mainly on the basis of typographic drying oils. The composition of the paint may vary depending on the purpose for which it is used. For example, when printing a newspaper, liquid paint is used, taking into account the rapid drying of the paint, and when printing books, some darker colors are used. In the preparation of all types of printing paints, wood resin and soap are added to the oil. In the literature, the composition of typographic dye is given as follows: typographic oil - 50 kg, wood resin - 10 kg, black dry - 12 kg, soap - 1 kg, color pigments 250 g. It is an olive oil that acts as a curtain. To remove the printing ink from the waste paper mass, it is first necessary to break down the component that forms the film. This means that the olive oil in the paint is an oily-waxy substance, and by converting it to a soluble state, the waste paper mass can be removed from the printing ink. When reusing all types of packaging materials, it is important to remove the dye while maintaining the physical and mechanical properties of the fibrous material. Studies have suggested 3.5% maleic anhydride and 15.8% specific polymer as the optimal content for dye extraction [12]. Another alternative method of extracting printing ink from waste paper is currently proposed by G. Tofani. To do this, to remove the dye from the paper sediment formed during the flotation cleaning process, it is fired at 5750C and bleached with sodium ditionite, the cost-effectiveness of reuse in paper production as a filler from the resulting ash is currently being studied [13].

A number of scientists have recommended the use of biotechnology to extract laser printer ink and printing ink from the waste paper mass. Experiments have shown that cellulose from Aspergillusoryzae MDU-4 for the removal of ink from newsprint, and lacquer isoenzymes from Ganoderma lucidumMDU-7 and 2 mMHOBt for cleaning laser printer ink have shown good results. Twin-80 has also shown the best results among the enzymes studied to break down toxic toner used in laser printers and remove it from the waste paper mass [14].

The method and efficiency of extraction of non-fibrous waste from waste paper is selected depending on the shape, size, quantity, composition and surface properties of the waste as follows:

- Treatment: waste size and their shape;

- sorting: waste size, their shape and viscosity;

- Washing: waste size and their shape;

- Flotation: waste size and their surface properties.

The size of the waste as printing ink is in the range of 1-100 μm, and their density is 1.2 - 1.6 g / cm3 [15]. Extraction of wastes with a density of about 1 g / cm3 from the waste paper, ie adhesives, waxes, paraffins and latexes, is a more difficult and complex process than cleaning from other wastes. In terms of waste size, the removal of waste, including glue and paint particles, which is the same as the length and diameter of the waste paper fiber, requires separate processes. [16].

Methodical part

The study examined MS-3 waste paper - paper waste consisting of books, magazines and archival papers as an object. The efficiency of the printing dye extraction process from waste paper is evaluated by the degree of polymerization of cellulose [17] and the capillary values of paper castings [18].

Main part

Previous studies in this area have shown that the removal of printing ink from MS-3 waste paper is mainly based on the bleaching of the waste paper, in which a printing ink is removed from a waste paper under the influence of oxidants and reductants[19]. In the study, the printing ink was extracted from the waste paper mass, but the capillary capacity of the paper samples prepared on its basis had low values. This is due to the fact that in addition to the coloring pigment in the printing ink there are various auxiliaries, including oil-wax substances - olives, the presence of which in the waste paper mass, adversely affects the printing properties of the formed paper.

In the study, the waste paper was treated in an alkaline environment in order to make the printing ink soluble. In this case, in the first stage of the process, the paper-waste paper first swells, then absorbs the alkali, and in the next stage, a chemical reaction takes place between the abrasive alkali and the oily substance. At high temperatures, in an alkaline environment, the waste paper swells excessively, and the average size of its pores increases several times, facilitating the diffusion of fatty substances in the printing ink. Under the influence of alkali, waxy substances hydrolyze to form sodium salts of fatty acids:

$R – COOH + NaOH \rightarrow R – COONa$

An extraction efficiency of a printing ink is evaluated by a degree of polymerization of castings and capillary properties of paper products made from it. For this purpose, MS-3 waste paper was treated at different concentrations of alkali at a temperature of 900C for 50-60 minutes. The results of the studies are presented in Table 1.

TABLE 1 INFLUENCE OF ALKALI CONCENTRATION ON WASTE PAPER QUALITY INDICATORS

#	Concentration of NaOH ,%	Polymerization level	A capillarity properties of paper castings, mm
1	1,0	850	4
2	1,5	820	6
3	**2,0**	800	7
4	2,5	740	9
5	3,0	710	10

Commentary: $t= 90^0C$; $\tau = 50min$

From the data given in the table, with an increase in alkali concentration, a slight decrease in the degree of polymerization of cellulose is observed, and as well as an increase in capillary properties. Repeated recycling of paper will result in lower quality of the collected paper, which will again increase the demand for primary fiber. It is also known that the quality of the paper decreases dramatically when the dye is removed [20].

Since an increase in the alkali concentration of more than 2% led to a sharp decrease in the degree of polymerization of the cellulose, its amount of 2% was accepted as the acceptable concentration. The increase in the capillary capacity of the samples can be explained by the fact that the film-forming agent in the printing ink is destroyed by alkali. The capillary rise of the liquid in the samples occurred as a result of the transfer of oligo-oily-waxy substances from the paper to the solution with increasing alkali concentration.

Although the decomposition of typographic dye was achieved with increasing alkali concentration, a sharp decrease in the degree of polymerization of cellulose was also observed. This is due to the rupture of hydrogen bonds in the cellulose macromolecule under the influence of alkali at high temperatures. Therefore, in order to reduce the alkali processing temperature, the effect of temperature on the process was studied, while maintaining the alkali concentration of 2%.

The results are shown in Figures 1 and 2.

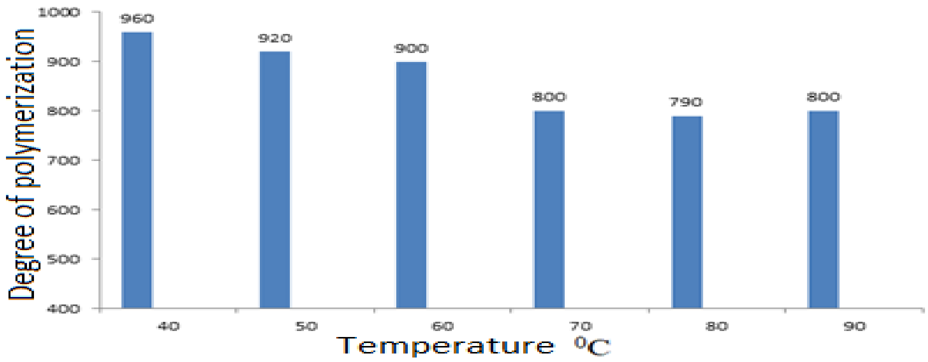
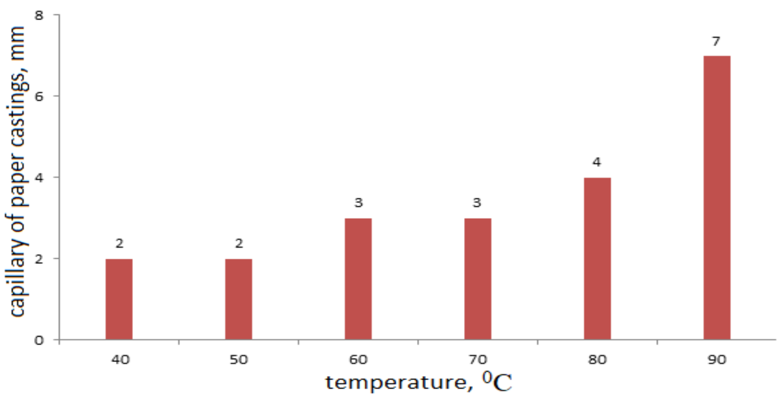


Figure 1. The effect of temperature on the degree of polymerization of waste paper



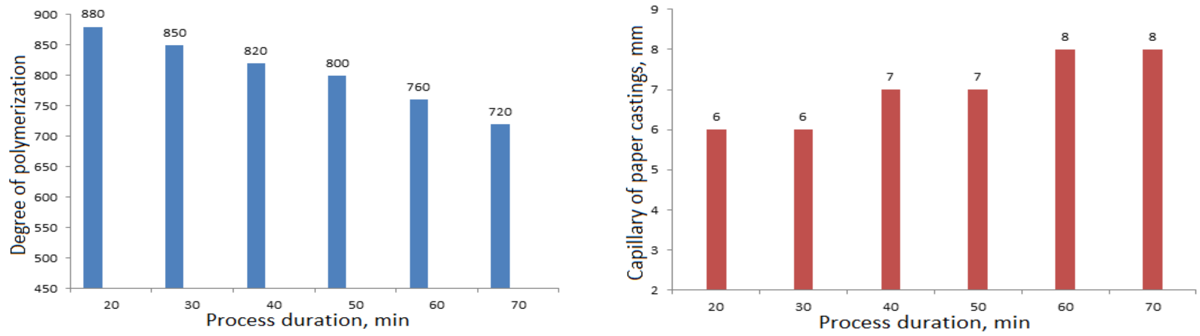
Commentary: C_{NaOH} = 2.0%; τ = 50 min

Figure 2. The effect of temperature on the quality of waste paper

The results given in the diagrams show that the polymerization rate of cellulose has a high value at low alkaline treatment temperatures, but the capillary rise of the liquid in the samples is observed only when the process is carried out at a temperature of 900C.

Hence, the hydrolysis of oily-waxy substances under the influence of alkali at high temperatures has been confirmed, a temperature of 900 C was accepted as the optimum temperature. Next, the effect of process duration on the efficiency of typographic dye extraction from waste paper mass was studied. The results are shown in Figure 3.

When analyzing the graphical data, it was found that an increase in the process duration of more than 50 min leads to a further decrease in the degree of polymerization, but the capillary is almost unchanged. Due to the fact that the amount of printing ink in the paper samples did not change, the system was in equilibrium for 50 minutes during the transition of alkali-oil-waxy substances to the solution under alkaline conditions.



a) b)

Commentary:C_{NaOH} = 2.0%; 90°C

Figure 3. The effect of process duration on waste paper quality indicators:

a) effect on the degree of polymerization; b) effect on paper capillary capacity.

CONCLUSION

The results (Table 1) show that as a result of alkaline treatment of the waste paper mass, the degree of whiteness and capillary content of the castings decreases with increasing alkali concentration in the system by more than 2.5%. This may be due to the formation of a hydrophobic layer on the casting surface as a result of the hydrolysis of drying oil and other oils in the printing ink under the influence of alkali, as well as the re-absorption of the pigment in the solution into the fiber. Wastes are also divided into separate classes in terms of wetting, i.e., hydrophilic, hydrophobic, and wastes that are wetted in a neutral environment. The method of removing the waste from the waste paper mass and the appropriate chemical and auxiliary reagents are selected according to the wetting environment of the waste. In addition to the above, wastes known to adhere to metal parts of equipment at high temperatures are also known as paraffin, wax, and latex.

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